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TRANSACTIONS.

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No. 886.

HEIGHT OF BUILDINGS.

An informal Discussion at the Annual Convention, London, England, July 2d, 1900.

SUBJECTS FOR DISCUSSION:

(1) "What Considerations Should Limit the Height of Buildings?"

(2) "Do Recent Developments in Construction, Sanitation, Intercommunication and Economy of Administration, warrant the Removal of all Restrictions?"

By Messrs. CORYDON T. PURDY, REGINALD PELHAM BOLTON, ROBERT W. HUNT, W. E. RILEY, H. DE B. PARSONS, R. J. GIFFORD READ, OSCAR J. KIRBY, JOHN F. WALLACE, MAURICE M. SLOAN and WILLIAM COPELAND FURBER.

CORYDON T. PURDY, M. Am. Soc. C. E. (by letter).—High buildings are the outgrowth of commercial considerations. They facilitate business, they increase ground rentals, and they offer opportunity for profitable investment. Mr. Purdy.

As the American mind is not hampered by precedent or biased by ancient customs, these considerations have easily outweighed popular prejudice, and even small American cities aspire to high buildings. In Europe there is more conservatism, but all the world is now striving for commercial advantage, and the pressure to make buildings larger and higher will probably increase there as it has in America.

Mr. Purdy. The problem as to whether or not the removal of restrictions as to height is warranted must be faced. The question is pertinent, therefore, in both Europe and America.

It is the writer's purpose merely to outline for discussion this topic: "The Limitation of the Height of Buildings," and to mention some of the points of interest exhibited by the photographs. Plate XVII, Fig. 1, is a view of New York City, from the North River, well south toward the Battery. In less than a generation, high buildings have changed the sky line of this part of the city completely. A few years ago the regulation five-story building line was unbroken except by the towers of churches. At present, Trinity spire, for many years

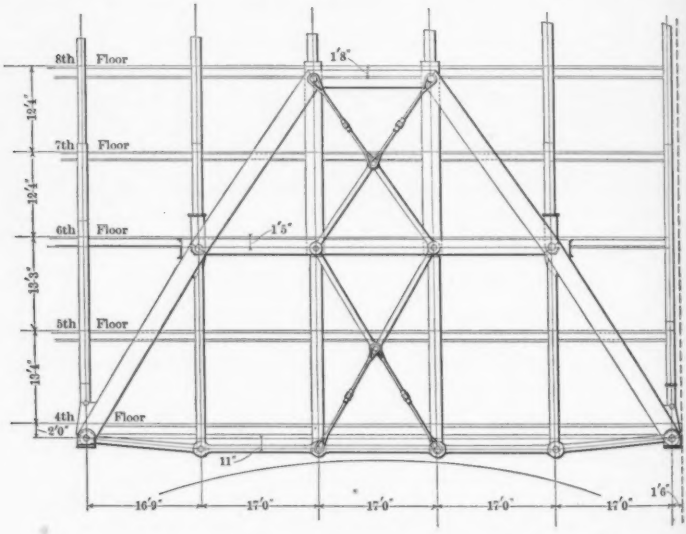

FIG. 1.

the highest structure in America, is looked down upon from the office windows of Wall Street and Broadway.

Many of the constructive problems in steel buildings are complicated in character, and they are not only so because of the variety of loads and strains which are sometimes involved, but because all lines of construction have to be worked out with reference to the uses of the building, the arrangement of its interior walls, and their openings.

The arrangement of the trusses over the great ballroom in the

FIG. 1.—SKY LINE OF LOWER NEW YORK CITY.

FIG. 2.—THE WALDORF-ASTORIA HOTEL, NEW YORK CITY.

Waldorf-Astoria Hotel in New York City, is a marked illustration. The lines of these trusses are shown in Fig. 1. The ballroom is 100 ft. long and 85 ft. wide and is without columns. It is three stories high. There are two great trusses sandwiched into the interior walls of the four stories directly over the ballroom, and their construction is worked out in such a way that their presence would never be suspected by people occupying the rooms immediately adjoining them. They carry 12 stories of bedrooms, weighing, with a reasonable allowance for live load, some 20 000 000 lbs. Some members of the trusses are heavier than can be found in any other structure in America. The lower chords are made up of nests of 12-in. I-bars carried on 12-in. pins. There is also one girder in this building 35 ft. long, which weighs 85 tons, and one column which carries 5 400 000 lbs. Mr. Purdy.

The completed Waldorf-Astoria Hotel, Plate XVII, Fig. 2, is the largest and finest structure of its kind in America, and possibly in the world. It cost about $5 000 000.

The Old Colony Building, Plate XVIII, Fig. 1, is one of the notable structures in Chicago. While it is narrow and high, it is also one of the stiffest high buildings constructed in that city. The scheme for the stiffening or bracing consists of four vertical lines located equidistant from the axis of the building. The portals, shown in Fig. 2, are placed one on top of another in such a way that the shear is conveyed directly from one to the other, and the columns are practically incorporated with the portals as a part of them. Their chief advantage is in the opening they afford between rooms. For all practical purposes they do not divide the space at all, and yet the desired bracing is obtained.

The exterior walls of this building were in process of construction at different heights at the same time (Plate XVIII, Fig. 2). This cannot be done in buildings of massive construction. The new building for the North American Trust Company, Plate XIX, Fig. 2, recently completed on the corner of Cedar Street and Broadway, New York City, was built in the same way. Plate XIX, Fig. 1, shows the completed building and also affords an excellent illustration of the splendid light areas which can be put in buildings of this kind.

Some buildings are built too high for their width. That at the corner of Wall and Nassau Streets, in New York City, Plate XX, Fig. 1, might be mentioned as one of this class.

The highest building in America is that known as the Syndicate Building on Park Row, in New York City. It is shown on Plate XX, Fig. 2.

The Broadway Chambers, Plate XX, Fig. 3, is another of the new high buildings in New York City. This building is exhibited by models at the Paris Exposition, where every feature of its construction is illustrated.

Mr. Purdy

Where buildings are now limited, the limitation is due to one or more of four things:

(1) Legal enactment;

(2) Economic considerations;

(3) Conditions of construction, concerning which law may not specify; and

(4) Popular prejudice.

In New York City the only legal limitation to the height of fireproof buildings is a provision that the overturning moment due to wind pressure shall not exceed 75% of the moment of stability, with the wind pressure taken at 30 lbs. per square foot, over every square foot of surface exposed. In Chicago the legal restriction has recently been fixed at 135 ft.

There are many things to consider in either fixing or removing restrictions to the height of buildings by law. First of all there is popular prejudice. Then there are:

The disturbing effect on land values;

The exclusion of sunlight from the streets;

The congestion of traffic;

The increased difficulty of fire protection;

The overburdening of established water supplies;

The inadequacy of drainage and sewers already constructed;

The disturbing effects on the business of building trades, architects, engineers and contractors; and last, but not least,

Æsthetic considerations.

Some of these considerations are more important than others, but all bear upon the problem. The writer believes that the height of buildings should have a reasonable limitation, but it seems to him that most of the real objections to the so-called "sky scrapers" do not hold with much force against buildings of fourteen or fifteen stories, or less.

High buildings have become possible through the use of new materials, the new use of old materials, notably the use of steel, and the development of the elevator.

It is also worth noting that the new buildings are better and simpler than the old ones.

They have more light.

The interior arrangement may be made in any way which may be desired and that arrangement can be changed at any time if desired; while

The strength of the building is in the steel frame, and that strength is susceptible of accurate computation, which brings with it a simplification of all problems of construction.

In conclusion, the writer desires to call the attention of our members to the fact that though in America we have wonderfully

PLATE XVIII.
TRANS. AM. SOC. CIV. ENGRS.
VOL. XLIV, No. 886.
PURDY ON HIGH BUILDINGS.

FIG. 1.—THE OLD COLONY BUILDING, CHICAGO

FIG. 2.—THE OLD COLONY BUILDING DURING CONSTRUCTION.

Mr. Purdy.

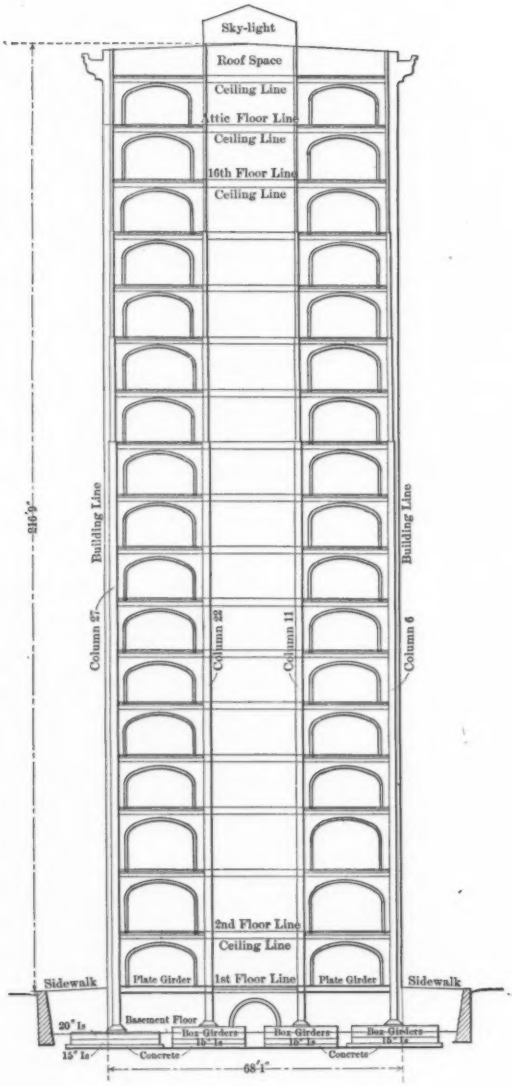

FIG. 2.

Mr. Purdy. developed the steel-constructed building, we owe a great debt to Europe for many of the ideas which have been used therein. It would be generally correct to say that European engineers have invented and Americans have developed.

One instance of this is sufficient to illustrate. As long ago as 1854, an asylum was constructed at York, England, by the Society of Friends, in which the floors were made of flat hollow terra cotta arches, of almost exactly the same pattern as we are now putting into our office buildings. They were designed by Mr. Pritchett, an Englishman. It has been repeatedly claimed by American writers that this arch was of American origin, but the first arch of this character was not constructed in America until 1873. Mr. Pritchett carried his arches over spans of 4 ft. 6 ins., which also accords with present practice. They were carried on cast-iron beams. The rolled beam had only been invented a year or two before.

Mr. Bolton. REGINALD PELHAM BOLTON, M. Am. Soc. C. E. (by letter).—The writer's professional connection with the equipment of large office buildings and hotels in New York City leads him to the conclusion that the limitation of the height of buildings should be left to practical and economic action, and that legislation or municipal interference cannot produce desirable results.

The law of England, protective of the right of so-called "ancient light," has operated to prevent the development of buildings and their consequent improvement. Progressive increase in the value of land in business centers will operate to the disadvantage of tenants unless relief be given in the only possible direction, viz., upward.

Concentration of trades and of business in certain centers is desirable and economical, and the advantage of the community at large is advanced thereby. Therefore an inconvenience which may temporarily operate to the disadvantage of individuals should be endured if the general welfare is advanced.

The writer believes that these general propositions will meet endorsement, but, in this particular class of public improvements, it is clear that the apparent inconveniences are more imaginary than real.

It is true that in a country where the proportion of bright daylight is limited, the value of window light is not to be lightly estimated, but modern methods of artificial light have so advanced as to greatly discount the positive necessity of window light.

Further, in the construction of a higher class of buildings, in a city such as London, the primary steps are sure to be soon followed by a general increase. The "city" has been, within the writer's memory, practically reconstructed from a three and four-story basis, to a height of five to seven stories without general inconvenience, and the advantages of a single lofty structure would be so soon grasped

FIG. 1.—NORTH AMERICAN TRUST BUILDING, NEW YORK CITY.

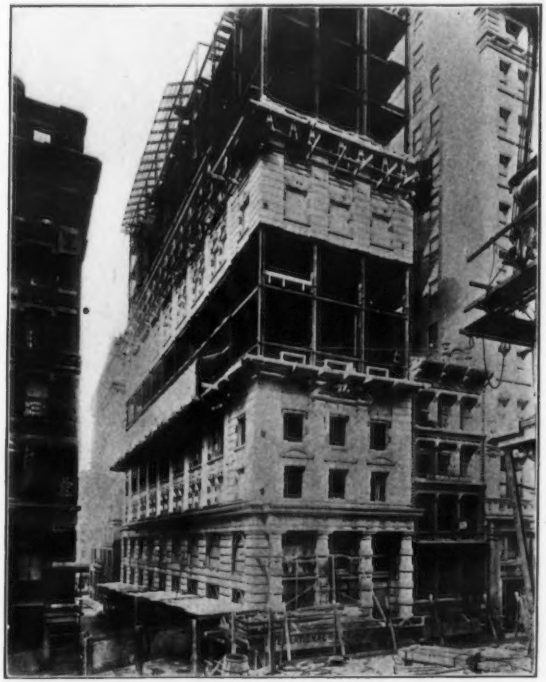

FIG. 2.—NORTH AMERICAN TRUST BUILDING DURING CONSTRUCTION.

that it would not be long before a general reconstruction of greater height took place. Mr. Bolton.

The construction of a tall building on a neighboring lot, while temporarily interfering with the immediate supply of light and, possibly, to some extent, of air, enhances the value of the neighboring properties, since on its success they become equally capable of increased development.

In the case of large office and hotel buildings the interior economy is such that artificial light and air supply can be and are generated at extremely low cost, less than is possible by public companies. Therefore a supply of both could be afforded to neighbors, in this way making up to them their temporary deprivations.

There cannot be any question that the general sanitation of a district is improved to an important extent by the construction of tall buildings, inferring, as this does, the effect of deep underground excavation and sub-soil drainage.

The writer can refer to instances in New York illustrative of this. When the Bowling Green Offices were constructed, the excavation extended 30 ft. below grade, and the sub-soil drainage was found to be extensive. Examination proved that a large part of it came from defective sewerage of the neighboring old buildings, the house sewer of one of which, a public restaurant, was found to be broken and choked.

This menace to health is, of course, now entirely removed by the sub-basement drainage system of the offices. Such cases could be multiplied indefinitely, and include wet walls and cellars dried, and insecure buildings supported and improved by neighboring structures of greater height and depth.

The relative increase in value of a piece of land, by reason of the construction of a lofty neighbor, may be gathered from what has proved to be the case in New York City.

Land, which with four-story buildings has barely paid expenses and taxation, has, with a lofty building, been able to earn all expenses; pay interest at the rate of 4% upon mortgages, the extent of which greatly exceeds the value of the original buildings; also pay a largely increased taxation, sometimes as much as five times the old rating; and, finally, leave a substantial profit on the net capital invested. The taxation borne by a certain property is relieved by the additional taxation placed upon an enlarged neighbor.

The writer believes that recent developments in construction, sanitation, intercommunication and economy of administration, warrant the removal of all restrictions, and further, he presents the proposition that natural causes will act as a restriction against excessive heights unless accompanied by proportionate areas. One of these is due to the limitations imposed by elevator service.

Mr. Bolton. The tall buildings which, in New York, have been the subject of most criticism, are chiefly those which, on a very confined area, rise to an extreme height. Their appearance, especially on the dead sides, is unsightly, and the architectural effects are almost ludicrous. The most flagrant example is the St. Paul Building, which has, perhaps, caused more criticism of the lofty building than any other.

It is in such buildings that the tenants of upper floors find their means of access of less convenience than elsewhere. For instance, in the building referred to, six elevators are installed, two serving the lower eight floors, two the intermediate, and two the upper eight floors. Each part of the building, therefore, is practically a portion of an eight-story structure, having only two elevators, a number certainly inadequate in comparison with others of equal height elsewhere. Moreover, the upper set of floors must be reached by a ride of 200 ft., equivalent to its location at that distance away from the main street.

The failure of architects to grasp the statistics of vertical traffic is not to be wondered at, the extraordinary feature being their attempt to deal with such a subject. They have not, as a class, learned that the necessary proportion of elevator mileage demands for a certain height a certain area, in which combination the proportions of a very high building becomes less offensive.

Further, the cost of maintenance of the upper floors in extremely high buildings is often disproportionate to their returns. These floors demand an excessive amount of heat for the winter season and increase the cost of house-water pumping. In addition, they must be debited with the larger proportion of the cost of the elevator service, and all these things being considered, they should produce a rental proportionately higher than floors below them. Such a proportionate increase is seldom applied, although some upper rooms are leased at high prices on account of the views they command, and their freedom from street noises. These features, and the elevation above the heated streets in summer, are found to be so well worth paying for, as to be the cause of the willingness of tenants to reside at an increased distance from the street.

The general conveniences of modern office and hotel buildings are so great as to justify much greater inconveniences than they cause.

The sanitary improvement over old and low buildings is great, and security from fire and increase of air space per tenant are worth general consideration.

It is due to the increase of size by means of height that mechanical improvements can be introduced which would otherwise be impossible except by the combination of a number of owners of contiguous properties.

In a recent article* the writer has given some of the figures of cost

* *Engineering Magazine*, June, 1900.

FIG. 1.—MANHATTAN TRUST BUILDING, NEW YORK CITY.

FIG. 2.—SYNDICATE BUILDING, NEW YORK CITY.

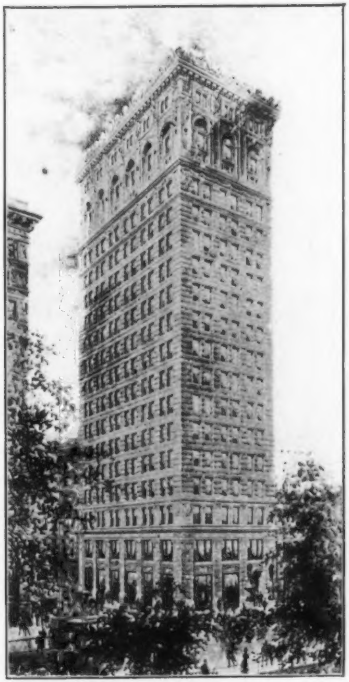

FIG. 3.—BROADWAY CHAMBERS, NEW YORK CITY.

of internal services, and has shown that the mechanical equipment reaches the proportions of a small central station, and can produce power in several forms under the most economical conditions. The fact that all the waste steam can be utilized for the necessary heating of the building in winter, and for other useful purposes such as heating water and cooking in summer, places these equipments in a position superior to the central station of public supplies. Mr. Bolton.

It is capable of proof that supplies of power in several forms can be sold by such large buildings to neighbors at figures very much less than the present cost of public supplies. Such advantages may thereby be presented to a contiguous property as will of themselves overcome the objection of interference with light or air, and the writer sees no reason why a tall building should not, by such arrangements, be a source of improvement to its older neighbors, and thus directly, as well as indirectly, add to their value.

ROBERT W. HUNT, M. Am. Soc. C. E.—Office rents vary in the different buildings and cities. The location controls the price just as it does under other circumstances. The speaker, ever since he has been in Chicago, has had offices in one of the first fire-proof high buildings built in that city. From the historical fact that the ground on which this building now stands was formerly occupied by such rattle-trap affairs that it was known, the city over, as the "Rookery," it was called "The Rookery" by the capitalists who secured the land from the city on a ground rent of 99 years. It is a building which will compare very favorably with any in the United States, although it was one of the first high office buildings. It is recognized from its location, history and associations as probably the most desirable building in Chicago, and as it can only hold a certain number of people, tenants have to pay quite the high figure named by Mr. Wallace, which is probably the highest rent charged by any of the buildings in the city. There are 3 200 people in the building. Its cost was about $1 800 000, and from its inception to the present time it has never paid its owners less than 12% on their investment, which makes it rather a profitable one for them. There are ten passenger elevators and one freight elevator, and the check which has been kept upon the number of people riding in them at different times shows that as many as 22 000 and 23 000 per day have been carried. Of course, that number does not represent different individuals, but the number of passengers carried. Every one living above the first story probably takes four rides a day, in addition to which there are business visits between the offices, and people coming to see the occupants. Mr. Hunt.

"The Rookery" is a town within itself. It has in the basement its own power plant, its own pumps, its own heating arrangements, its own electrical service. It has its own carpenters, its own painters, its own plumbers, and every mechanic necessary is employed in the build-

Mr. Hunt. ing permanently. They start from the roof and work down to the ground as regularly as the years roll on. By the time they reach the ground itself or the basement, the top of the building is in a condition to need their work once more, and they repeat the process, so that the building, after its 12 or 13 years of life, is just as good as it was the day it was built. The speaker is under the impression that the rate of rent his firm pays for New York offices in the Empire Building, at 71 Broadway, which is one of the newest buildings, is a little higher than that paid in Chicago.

Mr. Riley. W. E. RILEY,* M. Inst. C. E.—The views of lower New York are hardly recognized by the speaker, to whom that part of the city was quite familiar twelve years ago. The geographical situation had always appeared to him to be a great difficulty; the narrow tongue of land between the broad East and Hudson Rivers, with the Harlem River on the north, completely hampers extension. The inventive mind of the American was driven to some expedient, and the evolution of high buildings was the result. The speaker desired, however, not to comment too much on American practice, but to describe European procedure.

This question had been approached from different standpoints. In the American tall building it is apprehended that the steel columns are the only portions of the structure which are carried to the foundations; they provide for the great resultant force of the building by carrying each story independently of the one above or below it. In the Building Acts in operation in London, Paris, Berlin and Vienna, it is laid down that the enclosing walls shall carry the structure, and, in the London Act of 1894, enclosing external walls are to be of the full thickness specified in the various schedules for at least half of their area.

The heights are also strictly limited in each of the cities named. In London, a building (not being a church or a chapel) must not be erected or subsequently increased to a greater height than 80 ft. (exclusive of two stories in the roof and of ornamental towers, turrets, or other architectural features or decorations), and, in a street laid out after August 7th, 1862, of less width than 50 ft., no new building shall be erected so that the height shall exceed the distance of the external wall from the opposite side of the street, without the consent of the London County Council. If the new street is over 50 ft. in width, the height may be carried to 80 ft., as if the building were in an old street; but if the street is, say, 49 ft. wide, the buildings upon it cannot exceed that height. The license allowed after 50 ft. width of street has been obtained may appear a little anomalous, but there is a very important further limit to height by providing for space in rear, and a governing angle.

The whole of the plot abutting on a new street, since 1894, must

*Superintending Architect of the London County Council.

have a space of not less than 10 ft. unbuilt upon, and from the extreme boundary a line of 2 to 1 (or 63.5°) must be drawn, and no projections above that line must be erected, except turrets, dormers and chimney stacks, and they must aggregate to limited portions of the width of the back frontage. Mr. Riley.

Some of the high buildings in New York must have very great cubical contents, but, under the London Building Act, the capacity is limited, *i. e.*, buildings for trade purposes, of a larger cubical extent than 250 000 cu. ft. and not exceeding 450 000 cu. ft., must not go beyond 60 ft. in height. That, again, is a very notable restriction. The greater cubical contents can only be considered on the ground that a particular trade renders it absolutely necessary for the operations of that trade.

Houses for the working classes cannot be erected to a height exceeding the distance of the front, or nearest external wall of a building, from the opposite side of any street, unless the working-class dwelling is 20 ft. from the center of the street. In Vienna, the height of dwelling houses to the top of the cornice must generally not exceed 82 ft., and the floor of the highest story must not be more than 66 ft. In Paris, the heights of buildings are determined by the width of the street upon which they abut, the height being measured from the pavement perpendicularly up the face of the wall, including all construction and ornamentation, and must not exceed 40 ft. for public ways less than 26 ft. wide; 50 ft. for public ways 26 to 32½ ft. wide; 60 ft. for public ways 32½ to 60 ft. wide, and a maximum of 66-ft. height for public ways of 66 ft. and over. No building must exceed seven stories above the ground floor.

During a congress at the Paris Exhibition which the speaker attended he noted that one of the Continental speakers drew some very forcible illustrations as to the height permitted for buildings in London, but the horror with which he spoke of buildings 22 stories in height, which are permitted in New York City, was quite indescribable. These are very decided comments on the proposition before us, viz.: "What considerations should limit the height of buildings?" These are the European views, which, as a rule, are not hampered by the geographical conditions which obtain in lower New York City, but the implied criticisms are clear where expansion is more practicable, as in other American cities. The conditions in London are such that it is very undesirable to permit a greater height than 80 ft. The width of the old streets is small, there are comparatively few buildings built of incombustible materials, and the difficulty of attacking and controlling a fire in a narrow street with a limited head of water needs no demonstration.

The limited sunshine in London should be regarded as a factor in considering the heights of buildings in relation to its open spaces.

Mr. Riley. Moreover, neighboring properties, which surely have vested interests in the light and air, should be duly considered. Lastly, the monumental character of some of the buildings in European cities, together with their association with the past history of their respective countries, would suffer more deplorably than they do even now if there were less consideration for the limitation of height. It appears clear, therefore, that it would be little short of a revolution in European cities to allow much further latitude in this respect.

The newest Building Code of New York City, which came into operation in October last, is an interesting document. In its provisions it is noticed that any hotel, lodging house, school, theater, jail, police station, hospital, asylum, institution for the care or treatment of persons, which exceeds 35 ft. in height, shall be built fire-proof, and every other building which exceeds 75 ft. shall be similarly constructed.

In a recent book* on fire-proof construction there are recorded some very interesting experiences on the behavior of high buildings in cases of fire. Illustrations are given of the Home Life Building, which the speaker did not remember to have seen, as it was probably erected since his last visit to New York. It is 192 ft. high, and was intended to be fire-proof, as all such high structures should be. A building of 5 stories adjoining it took fire and burnt out every floor of the Home Life Building above its own height. The disaster appears to have resulted through a shallow court 20 ft. wide, used for lighting the higher building, drawing up the flames and communicating them from one window to another in the progress of the fire in the higher building. The court acted like a purposely constructed chimney in its destructive effect, though how a reputed fire-proof building burnt so freely and fiercely is not so apparent.

A court of this character could not be built in a new building in London. The limit of height of the parapet above the sill of any such window, if used for a habitable room, is twice the root of area of the court, and, in case of a room used as an office, would be limited to the general height permissible under the act, but in no case exceeding 80 ft.

The destruction of the Windsor Hotel made a great impression in this country. It was substantially built, and it was stated in some papers to have been fire-resisting, though that statement is inaccurate, as it was elicited that the floors were of open wood joists; some of the partitions were formed with "quarters" and the internal finishings were wainscoting. Such a building would hardly be classed as fire-resisting here; at any rate, it burnt with such furious rapidity that it was practically gutted within an hour and a half. There is no doubt that every such building should be as uninflammable as modern

* "How to Build Fire-proof," by Francis C. Moore, New York, 1899.

science can make it. The responsibility of dealing with life and property in such a structure is a burden no public official should be called upon to undertake. In spite of the most heroic efforts, and an expert corps of fearless and brave men, many lives were lost and the property totally destroyed. In the case of the Home Life Building the water pressure was 108 ft., but that failed to save the building up to that height. Mr. Riley.

The means of escape in case of fire are constantly engaging attention in London, and, at the present time, further powers in regard to the provisions of the Factory Act are now being sought from Parliament.

With the foregoing examples on record he would be a bold man who would recommend any serious increase in the height of buildings in London.

The next question for discussion is, "Do recent developments in construction, sanitation, intercommunication and economy of administration warrant the removal of all restrictions?"

Modern construction has materially improved the conditions and lessened the risks of escape in case of fire, but construction has little beneficial effect upon provisions which deal with width of streets, proximity to other buildings, and the open spaces about buildings. It needs little demonstration to show that restrictions of height of buildings secure the essentials of light and air which are required for proper sanitation, intercommunication and economy of administration. There is no doubt that the ingenuity of American engineers has made the tall building work with a facility which could hardly have been thought practicable a few years back. The Produce Exchange is remembered as the highest building in New York fifteen years ago, and in London would still be considered as a very tall building, although it is now overshadowed. Expansion in London is inevitable, and efforts must be made to improve the communication with outlying areas. The solution appears to be looked for in building in the suburbs where the inhabitants can enjoy fresh air, and simultaneously provide rapid and reliable means of transport to the central points. There is no apparent demand for increasing the height of buildings, and none for the removal of all restrictions; here it would be a calamity to adopt any such legislation.

It is difficult to approach these questions of comparison without being dogmatic, especially when convictions are strong, but the few remarks submitted will, it is hoped, be accepted in another spirit. The subject is one of great interest, and the developments have been carefully watched. Many experts in New York City are bitterly opposed to high buildings, and they freely condemn the result of recent years' work as a hideous disfigurement of the city. These views find many supporters here, but perhaps a better acquaintance with the conditions which made the problem might soften the criticisms.

Mr. Riley. American engineers and architects are hampered by no insurmountable traditions. When a city railway was a necessity it was not put in an "underground" tunnel, as in London, but erected on stilts, and it answers its purpose very well. When a luxurious ship was wanted for the Fall River traffic, the *Pilgrim* (probably out of date by this time) was evolved. Her beam engines and other features appeared antiquated twelve years ago, but a closer acquaintance with the conditions revealed that the type adopted had much to recommend it. The systematic method of American thinkers has been to first grasp the difficulties to be overcome, and then attempt to solve the problem in the most practical and common-sense way, unbiased by prejudices. If the tall building is not all that can be desired, it is another effort to solve a difficulty, and, as experience is gained, it may ultimately lead to some satisfactory result, but it is not a suitable form of structure for this part of the world.

Mr. Parsons. H. DE B. PARSONS, M. Am. Soc. C. E.—Designing a tall building is a much more difficult problem than one would ordinarily conceive. "Fire-proof," "cage" and "skeleton" construction are three terms frequently used in connection with these buildings, which it would be well to define. By "skeleton" construction is meant that the outside walls of the building are self-sustaining, that is, they are carried up from the foundations as permanent walls. The interior of the building is supported upon a skeleton construction of steel or iron. By "cage" construction is meant that the building is supported *in toto* by the metal framework. The outside walls are mere curtain walls, and are supported themselves by the metal construction. Good examples of this construction have been shown by Mr. Purdy. The word "fire-proof" is used in a generic sense. It is impossible to conceive of any building which is intended to be inhabited and to contain the conveniences which the man of to-day demands, that could be built so as to be uninjured by fire. Fig. 1, Plate XXI, is a picture taken from the twentieth story of the American Surety Building, No. 100 Broadway, New York City, looking south, and gives a good impression of the height to which these structures tower. Wall Street, although only about 150 ft. distant from the building, is lost in the foreground. The Empire Building, No. 71 Broadway, which has been mentioned in this discussion, can be seen on the right in the picture. The low building shown on the left is that of the Union Trust Company, and was once considered tall, but it is now very much overshadowed by the next building beyond, namely, the Manhattan Life. The Bowling Green Building is seen in the distance and the Bay beyond. Looking down into the street below, one cannot refrain from imagining the difficulties which are encountered in the protection of these tall structures against the ravages of fire. Of all the elements which are tending to destroy these buildings, probably there is none

FIG. 1.—VIEW FROM TWENTIETH STORY OF AMERICAN SURETY BUILDING

FIG. 2.—THE MANHATTAN SAVINGS INSTITUTION.

so potent as fire. It will be interesting to show a few examples, pick- Mr. Parsons.
ing out the worst cases rather than the best, in order to bring out the subject in the strongest light. In the first place, these buildings should only be constructed in the most fire-proof manner. It would not be good practice to build them according to the ordinary methods of construction, such methods as were mentioned in connection with the Windsor Hotel. Fig. 1, Plate XXII, represents the Windsor Hotel, New York City, which was destroyed by fire on March 17th, 1899. The hotel, of which this picture only shows a part of the front, was 200 ft. in length and was built in the form of a shallow U, the wings of which were 180 ft. in depth. In the rear of the hotel there was a court. The weakness of the building to resist fire was the design and the method of construction. At the center of the building and on the roof was located a large water tank. Through some error in the design, or through some change of plan, it is said that part of the building was supported from the roof by tie rods, the tie rods being carried by girders. The fire originated in the basement and spread with fearful rapidity throughout the building. It was known in New York as a dangerous building, owing to the wide corridors which ran from end to end on every floor, without any fire division walls whatever. This picture shows the building a few moments after the arrival of the engines. The fire was in the corridors behind the front rooms.

A few moments afterward, probably not more than two or three minutes, the photograph, Fig. 2, Plate XXII, was taken. A tongue of flame had burned away the flag, and the building began to tumble in a central vertical section. The break occurred so quickly that the firemen had hardly time to get out of the way.

Almost immediately after the last picture, the conditions were as represented in Fig. 3, Plate XXII. The tank had dropped from the top to the bottom, and that condition of affairs existed 35 minutes after the fire-alarm was given. Within a few moments afterward fire burst from almost every window simultaneously. Fig. 4, Plate XXII, represents the condition about 45 minutes after the alarm was sounded, and was taken just previous to the fall of the wall. It was only 5 or 10 minutes after the south wall fell, that the north wall gave way and the hotel was completely ruined.

Many imagine that buildings constructed of iron, steel, cement, glass, slate, and tiles are fire-proof and indestructible, but such is not the case. In the Washburn & Moen Company's Quinsigamon Mill, which was built on the "cage" construction plan, the walls were merely curtain walls. The window frames and sashes were all iron and steel, and the only wood used was in the floors and roof. The floors were built on the slow-burning principle. The structure was not overloaded at the time. It was a building used for the manufacture

Mr. Parsons.

of steel springs, which are not in themselves combustible, and the reason the fire spread so rapidly was probably due to the fact that in one part of the building there was an oil-tempering room, and the vapors from the oil baths had condensed on the under side of the floors.* The columns yielded within from 15 to 25 minutes after the fire started. Experiments which were made by the Committee on Fire-Proofing Tests agreed very closely with the facts recorded in this fire. The plate to which reference is made illustrates very completely the destruction; and, when viewed from the standpoint of insurance, can it not be said with truth that iron and steel buildings will burn? Certainly, the destruction was complete.

The danger from fire in all large, tall buildings is greater from the hazard without than from any risk within. A fire, starting within a building which is of fire-proof construction, can be localized and put under control. But many buildings are subjected to an external hazard which is very great, owing to the large window areas and to the fact that there are windows on every floor, so that the fire may attack the building on all floors at once. Fig. 2, Plate XXI, shows the destruction of the Manhattan Savings Institution, New York City, during the winter of 1895 and 1896. It was at that time a modern building, and was well constructed so far as the materials were concerned. A building at the opposite side of the street caught fire; and the heat broke the glass of the windows, and was sufficient to warm the under-side of the girders which were exposed. They yielded; some, expanding, pushed out the walls, dropping the floor beams, and the building was a total wreck. Nothing was saved except some of the structure on the first or ground floor, and none of the fittings was in a condition to be used again.

On May 3d, 1897, there was a fire in Pittsburg, Pa., which originated in an old building containing a great mass of combustible material. Owing to the wind, it spread rapidly to a number of small buildings of similar construction, and attacked three modern buildings of the fire-proof kind. Reference may be made to the paper † by Corydon T. Purdy, M. Am. Soc. C. E., describing this fire. Fig. 2, Plate III, of that paper, shows part of the first floor of the Joseph Horne Dry Goods Store. It was a modern building, well constructed and well built, but in its construction there was in many points a total disregard of any fire hazard. The fire-proofing material stood well, and no fault could be found with it. The débris in the corner was caused by faulty design. On the roof there was a 5 000-gall. water tank, which was supported by unprotected iron girders and beams. Iron and steel, as shown in the Washburn Mill, will not stand unless protected. The

* Part of the ruins of this building are shown on Plate X, *Transactions*, Am. Soc. C. E., Vol. xxxix, June, 1898.

† *Transactions*, Am. Soc. C. E., Vol. xxxix, p. 121.

FIG. 1.—WINDSOR HOTEL FIRE.

FIG. 2.—WINDSOR HOTEL FIRE.

FIG. 3.—WINDSOR HOTEL FIRE.

FIG. 4.—WINDSOR HOTEL FIRE.

result was that the tank fell from the roof to the basement. The damage done to the structure by the falling pieces was probably greater than the damage done by the fire. The well, which extended up through the building to give certain architectural effects and to give light to the lower floor, proved to be very hazardous. The fire was drawn up by the current of air and carried to the other floors as though the well were a flue. Mr. Parsons.

Another view on the same floor of the same building is shown in Fig. 1, Plate IV, of Mr. Purdy's paper, and illustrates in a better manner the effect of the fire-proofing. All ornamentation is gone, but the fire-proof blocks were well preserved. Again referring to Mr. Purdy's paper, Fig. 1, Plate III, and Figs. 1 and 2, Plate V, show the exterior of the buildings after the fire. The damage in the Horne Office Building was very much less than in the Dry Goods Building, and was due to a better arrangement of fire-proof partitions. The location seems to be unfortunate, as the Dry Goods Store was rebuilt and has been burned a second time.

Mr. W. E. Riley has mentioned the Home Life Building, in New York City, as having been attacked by fire. Fig. 1, Plate XXIII, shows this building before the fire. It is 16 stories high, 192 ft. to the roof, and 242 ft. to the top of the tower. The low building at the right was of ordinary construction, occupied as a clothing house, and caught fire. The tall building next to the Home Life Building is the Postal Telegraph Building. The wind was blowing at hurricane force, unfortunately, from the northeast, so that it blew against the side of the Home Life Building, which contained a court or light well. The flames were drawn into the well, which acted as a chimney, and, as all the windows were unprotected by shutters, the fire entered simultaneously every floor of the building above the ninth.

Fig. 2, Plate XXII, shows the building after the fire, and also the well or court just referred to. Of course, the small corner building was completely ruined. The destruction of the façade was complete from the ninth floor upward. Below that level, the building was practically intact and was used again by the tenants within a very short time after the fire. The contents of the seventh and eighth floors were badly damaged by water. The elevators and the staircase were located next to the light well, so that the flames on entering the building had free access to every floor.

Fig. 1, Plate XXIV, is typical of any room in the Home Life Building, above the ninth floor, after the fire. The fire-proofing stood the test, and was found to be in such good condition that most of it was used over again without any expense. The partition walls had large transom windows which were unprotected, and were fitted with ordinary glass set in wooden sashes. When the fire entered a room, it simply broke the glass and passed on to the next. Had these partitions been of a

Mr. Parsons. fire-stop character, all damage would probably have been confined to the rooms next to the building which originally caught fire.

Fig. 2, Plate XXIV, shows a wire-lathe and plaster partition which had been built on the wooden floor. The floor was laid on wooden sleepers, leaving an air space between the fire-proof arches and the wooden flooring. If this building had been constructed, as was originally intended, and as all such buildings should be, by filling this air space with ashes or concrete, and by resting all partitions directly on the arches, the probabilities are that the fire would not have damaged the partitions. As it was, when the wooden floor had been burned away, the partitions had no support and simply dropped.

The greatest damage to the steel frame-work is shown in Fig. 3, Plate XXIV, which represents a view of the front room on the sixteenth floor. The large girder had its lower chord well protected, but the upper chord projected above the floor level. This girder was covered with a flooring, raised in a sort of step toward the front wall. The wooden floor soon burned away, leaving the upper chord entirely exposed. It became red hot and buckled, as shown. The photograph does not illustrate very well the damage to the façade and window trim, owing to the strong light. The missing fire-proofing blocks were removed from the column after the fire for the purpose of inspection, and this column, as well as all the others, was found to be in good condition. The blocks seen on the floor were knocked off by the firemen and by the City Building Department, and were not displaced by the fire itself. The heat in this room was very great, and, as can be seen, no plaster remained on the walls.

The marble front of the building, from the ninth story upward, was taken down and rebuilt. The Postal Telegraph Building was injured on the upper story by fire and only damaged by water on the floors below.

As a fire-stop, these tall buildings certainly acted marvelously well. It would be frightful to contemplate what might have happened during that gale of wind had these buildings not been there; but, of course, tall buildings are not intended as fire-stops.

In case of fire, any door or window opening is dangerous. The way to stop a fire from spreading is to confine it to the place where it originated. If circumstances necessitate a large floor area, then make such area a fire-proof floor and ceiling, cutting off all communication with the rest of the building. If possible, put the staircase in a tower-like structure on the outside, and give access to each floor by a bridge. Make all communication from one floor to another pass across the bridge, up or down the stairs, and back over another bridge to the next floor. It is best to subdivide large areas by fire-walls or by fire-proof partitions and have as few openings as possible. It is an impossibility not to have doors and windows in tall buildings, but such openings

PLATE XXIII.
TRANS. AM. SOC. CIV. ENGRS.
VOL. XLIV, No. 886.
PARSONS ON HIGH BUILDINGS.

FIG. 1.—THE HOME LIFE BUILDING.

FIG. 2.—THE HOME LIFE BUILDING, AFTER THE FIRE.

create a hazard. When the divisional walls are cut in numerous places, it is hard to conceive of a fire-proof building which could not be injured by fire. The danger from without is usually far greater than that from within. Mr. Parsons.

In the United States, many prefer the "slow-burning" construction, and a wooden building made on this principle will outlast an ordinary steel building, unless the steel building is put up in the most approved manner, with the members covered with the best fire-proofing, but this construction is not suitable for very high buildings. The "slow-burning" method simply consists in using large pieces of timber for posts and girders, so that the fire can char to a depth of 2 ins. or more without impairing the strength necessary to support the loads, and constructing the building so as to leave no air spaces. It takes a long time for fire to char a large stick to that depth, and by that time the fire department can come to the rescue.

The lower floors of the Home Life Building were uninjured, because they were protected by the brick wall of the adjacent building which first caught fire. There is nothing better than an ordinary brick and cement wall, and such a wall protected the Home Life Building. The flames had to pass over its top, and then had an upward tendency from the draught of the well and elevator shaft, and the first windows which really got the attack of fire were on the level of the ninth floor. The ninth floor practically marks the limit of protection from the Fire Department in the street.

Tall buildings are now constructed with stand-pipes, which are large pipes 6 or 7 ins. in diameter, extending from the street level to the roof. At each floor there are arrangements whereby the fire hose of the building can be connected to the stand-pipe, and the City Fire Department engines connect with the bottom of the stand-pipe. The engines pump water into the stand-pipe and the firemen use the hose which is on each floor. In that way they save much valuable time as they do not have to carry up their own hose to great heights. In some tall buildings the elevators or lifts are in commission night and day for the purpose of fire protection, and in case of alarm the elevator is immediately sent to the lower floor to be ready to carry the hose or the firemen to the proper point.

The fire-door which has generally been found the most serviceable in the United States is that known as the Underwriter's door. It is simply a wooden door sheathed with tin. The door is often strengthened by being made of double plank laid diagonally. The coating is of ordinary tin well lapped. These doors will stand an enormous amount of heat before they fail. They are carried on a traveler overhead. The traveller is on an incline, and during working hours the doors are held back by a cord, a wire or a chain, in which there is a fusible link. The link operates the same as the sprinkler; at a certain

Mr. Parsons. temperature, which is quite low, it melts, and the door closes automatically. Many forms of patented fire doors have been used, but none with such universal success as the Underwriter's door.

Mr. Read. R. J. GIFFORD READ, Assoc. M. Inst. C. E.—Some wonderful examples of the disastrous effects of fire on ironwork have been shown in this discussion, and attention specially called to the efficient protection which the fireproofing afforded. The speaker would be glad to know what material the fire-proofing was made of, whether it was of the nature of plaster, terra-cotta or brick.

He thinks that the views show in a very clear and impressive manner the effects of fire on these high buildings.

With regard to the case where the fire originated in the eighth story and spread upward through the elevator shaft, he would like to ask how the people who were above escaped, and if, in tall building construction generally, there is any other method provided for escape than by the elevators.

In certain high buildings in London on which he had been engaged, provision for escape was made by outside balconies and staircases, or by outside galleries connecting one building with the next, or by escape ladders to the neighboring roofs, but these would scarcely apply in the very high American buildings.

Mr. Kirby. OSCAR J. KIRBY, Esq.*—In high buildings of six and seven stories the speaker uses corrugated steel doors with asbestos sheeting on either side, so as to cut off entirely one room from another, the grooves or corrugations being filled with ground clinker to give solidity to the doors. Bolts or rivets keep the faces of the doors compactly in position, the bolts being so arranged, where necessary, that they can be covered over with moulded asbestos to give the faces of the doors the appearance of wrought woodwork.

These doors, unlike the composite fire-proof tin-covered wooden doors, do not warp in a fire and break loose from the hinges or fastenings.

Mr. Wallace. JOHN F. WALLACE, President, Am. Soc. C. E.—The cost of high buildings in Chicago has varied from about 30 to 40 cents per cubic foot, and the rental for office room above the ground floor has varied from $2 to $2.50 per square foot per annum. Of course, this cost of construction and rental received varies largely between buildings differently located. The rental generally includes janitor's service, elevator service, and sometimes heat and sometimes light. These figures may have been modified in the last two or three years.

High buildings had, not their origin, but their highest development in Chicago, and they were not constructed in order to get something larger than existed anywhere else in the country, as some people might

* Engineer and Surveyor to the Batley Corporation.

FIG. 1.—TYPICAL ROOM IN HOME LIFE BUILDING AFTER THE FIRE.

FIG. 2.—PARTITION OF WIRE-LATH AND PLASTER.

FIG. 3.—FRONT ROOM, SIXTEENTH FLOOR, HOME LIFE BUILDING.

have an idea, but from the circumstance that the business portion of Chicago is confined to a very small area. The Chicago River comes in from Lake Michigan for a short distance and then branches in a northwesterly and southwesterly direction, forming a Y. In the district south of the river, and between the river and the lake, what is known as the south side, the principal business of Chicago is carried on. The railway stations all have their termini within a comparatively small area, and the wholesale as well as all the retail houses are located in this district. The price of land per square foot, therefore, became very high on account of the congested business, and it was impossible for land owners to obtain for low buildings a rental which gave a reasonable return. In order to overcome this, and in order to receive an adequate return upon the assessed and market value of the land, they were forced to construct high buildings. In New York and other large cities of the same character it has not been a question of architectural beauty, nor a question of sanitation, but simply a business and commercial necessity. Therefore it may be interesting to our English brethren to have some idea of what those buildings cost and what rental they return. This would seem to be the key-note of the whole question. Mr. Wallace.

In order that our English brethren may understand the situation in America it may be desirable to say that all American engineers do not favor the continuation of the construction of high buildings, even in large cities, and are very much divided in opinion on that subject.

Answering Mr. R. J. Gifford Read's questions: In the first case this fire-proofing is generally terra-cotta work. In the cage construction, in between the floor beams the floor is constructed of a series of terra-cotta blocks which are made with inclined joints and so formed that they make a flat arch. In order to make the blocks light they are made hollow; hollow tiling or terra-cotta work is also built around and envelops the columns, and in some cases it is joined by cement or is keyed around the columns. In the later constructions the fire-proofing is very carefully put around all the iron and the steel columns. Steel floor beams are not now looked upon as a fire-proof material. They simply furnish the ribs or the skeleton, as it might be called, on which the fire-proof construction is placed. At an earlier date concrete was used for these floors, and thin strips of wood were placed in it and the wooden floors nailed to these strips. In the later construction the floors are made of concrete on the top of this fire-proof terra-cotta work, and then small stones are put down in mosaic work and are then smoothed over. This makes the fire-proof floor, so that now, in a great many buildings, there is no wood except simply the doors and the window cases.

With reference to fire-escapes, in all American cities where high buildings are used, a certain number of fire escapes are now obligatory

Mr. Wallace. by city ordinances, and they are required to be constructed on the outside of the buildings, generally in connection with balconies and at the ends of the halls, and the number placed is in proportion to the size of the building. They are inspected periodically by the city authorities. The fire-proofing of buildings has received of late years serious consideration. When these buildings were first constructed it was supposed that the iron and steel work was fire-proof and would not yield so readily to the heat. The character of the occupancy of the buildings has a great deal to do with them. They are well adapted to office buildings in the congested portions of the city, but they are not adapted to retail business or dry good stores, or to any business where the contents are highly inflammable, except where they are constructed with fire walls and fire partitions and with isolated rooms. In Pittsburg, Pa., in a hotel of recent fire-proof construction a fire occurred in a suite of rooms, and two rooms with their furniture were entirely destroyed and burnt out. The occupant of the adjoining room did not know there was a fire until informed of it the next morning. That was due to the careful design of the building in reference to fire walls, terra-cotta work and the use of cement, concrete and mosaic floors, and the absence of transoms over the doors.

Mr. Parsons has given us some information regarding fire doors, and the speaker can answer with regard to some warehouses in the City of New Orleans, which have been constructed under his immediate control. One warehouse was 1 200 ft. long and 100 ft. wide, for the storage of cotton, cotton-seed oil, and products of that kind, which are highly inflammable. That building was constructed with brick foundations up to the level of the floor and then filled in with earth, upon which a concrete floor was constructed, dividing it up into sections. Very narrow openings were left between the different sections, and were protected from each other by what might be called twin doors, with an air space between them. It is not permitted to pile any material within a certain distance of these doors.

Mr. Sloan. MAURICE M. SLOAN, Esq. (by letter).—The public good, or the common welfare of the community, is the only consideration that should regulate the height of buildings, and the law of common weal, though sometimes slow, is ever present and a governor of all things human.

This is undoubtedly the legal aspect of the discussion, for it places the rights of the owner, on the one hand, to build as he chooses, over and against the rights of the people, on the other, to restrict as they deem advisable.

The restrictions placed upon the height of buildings by a community should be confined entirely to such as they have a right to impose. That public prejudice and æsthetic considerations should interfere with the owner's individual right to build as high as he pleases is unreasonable and absurd. Public prejudice is undoubtedly

a strong factor, but the world would have remained in an exceedingly primitive state if it had always obeyed the admonitions of this fickle and somewhat unreasonable goddess, while æstheticism, with its principles and doctrines, so often results in mere whimsicality or grotesqueness that it cannot be taken as an imitable law, and is not worthy of consideration in so vital a question as that under discussion. Mr. Sloan.

Where the height of a building, however, affects the safety of either the individual or the community, and jeopardizes life and health, or even stagnates commercial operations by congesting the traffic in the street upon which it is located, restrictions should be fixed, and too much care cannot be exercised in determining what should be the limitation.

That a building may be constructed to any height with perfect safety is a proposition generally accepted, though many conjectures arise as to the terrible havoc and loss of life that would be caused should earthquakes of great severity, or cyclonic storms of unusual violence, devastate the modern city of skyscrapers. These conditions are, however, of such a cataclysmic nature as to entirely preclude them from an argument for or against high buildings.

From a hygienic point of view there is little doubt that tall buildings are a menace to the health and happiness of a community. Sunlight is a natural disinfectant, and should be allowed to penetrate to every city street, flooding it at least for a few hours each day with its purifying rays. The fulfillment of this seemingly unimportant condition is really of vital moment, and can illy afford to be neglected in a great city teeming with a population susceptible to decimation by contagious and infectious diseases.

It would almost seem that this consideration was of sufficient importance alone to regulate the height of buildings, and would give a basis to work from, at least in temperate climates, that would insure light and airy streets, free from the miasma which is so typical of the narrow passageways between high buildings in a city. Such a basis of determination would not only satisfy the exacting requirements of the sanitary engineer, but would in many cases meet the demands of the æsthetician.

In considering the necessity for providing sunny and healthful streets, take for example the conditions as they exist in New York. This city is in latitude 40° 43′ N., and the sun's declination is 23° S. in midwinter, that is, on the 22d of December. The altitude of the sun at noon is found by the formula:

$$\text{Alt.} = 90° - (\text{Lat.} + \text{Decl.}),$$

and equals 26° 17′, giving a zenith distance of 63° 43′. Assuming a building 100 ft. high, located on a street extending east and west and letting the width of the street represent the tangent, and the height of the building the radius of the angle 63° 43′, the width of the street

Mr. Sloan. necessary in order that the sunlight may penetrate to the foot of the opposite side walls would be 202 ft. Such a street would be entirely too wide and pleasant for the economist and utilitarian, but, after all, would it not make a city of such healthfulness and beauty as to be the envy of the world.

While it is true that the sunlight could never, at least in winter, penetrate to the entire street, the reflected light from the opposite wall would be all that was necessary to promote a healthful atmosphere and light buildings and streets. The width of the street, figured on this basis, would also take care of any possible traffic brought about by the usual commercial transactions. It is universally understood, and conclusively proven, that recent developments in sanitation, intercommunication and economy of administration, remove all restrictions relative to the height of buildings. There are, however, limitations imposed by economical construction which will prevent the height of buildings from exceeding that already attained at the present time.

One of the factors which will tend to limit the height of buildings is due to the fact that as the distance from the foundation to a story increases, the investment required to construct that story is likewise increased, and as the returns on the investment are not subject to such an increase, there is a limit beyond which it is unprofitable to go. Such a condition arises from the fact that the increased sectional area required in the columns to support a given floor extends not only throughout the length of the columns in the tier below, but throughout the entire distance from the floor in question to the foundations. Similar considerations apply as well to the wind bracing, especially where diagonal bracing is used, and where the building is regarded as a cantilever beam supported at the foundation, for the wind bracing at any floor must be proportioned to sustain the increment of stress from all the floors above.

It is such conditions as these that have made the growth of the ocean liner and the locomotive slow, and kept the span of bridges within reason, and will likewise prevent the design and construction of buildings of greater height than those at present erected.

Mr. Furber. WILLIAM COPELAND FURBER, M. Am. Soc. C. E. (by letter).—The real trouble with the high building and its relation to adjacent buildings is, that it has become a misfit in the present city block plans and streets, and, because of this misfit, this relation has become one of the principal factors in determining its height, sanitation, and intercommunication. Many of the objections to the height of buildings disappear as soon as they are isolated from their neighbors a sufficient distance to allow circulation of air, an adequate amount of light to answer sanitary requirements and the needs of tenants and neighbors.

The high building is a great concentration of available rentable

space for the transaction of business, with the least amount of waste time and energy. Its great aggregation of floor space within convenient limits, makes it possible to provide for all the proper conveniences and many of the luxuries which lighten labor, at a cost which justifies their purchase by tenants. Taking an average of say 12 ft. from floor to floor, every 12 ft. in height doubles the area of the ground occupied, so that, from a given point on the pavement, within a comparatively small vertical distance (which requires no laborious effort to reach), the available area of the land is increased as many fold as the number of stories. Mr. Furber.

With the acquisition of any advantage, however, experience shows that many drawbacks usually accompany it, but wisdom points the way toward a compromise of some of the good features of the one, to avoid some of the evils of the other. We cannot have all the land occupied, and the high building at the same time, without bringing in a train of evils, due to overcrowding. High buildings, like great men, need room to develop their capacities. The high building, to be suited to its surroundings, demands a rearrangement of the city block plans, making each large structure a block of itself, with wide main streets and subordinate streets of sufficient width for fire protection, light and ventilation. The high building should have no party walls, and the necessity for them would disappear upon making each structure a unit. Congestion of street traffic would also be relieved to a great extent by the increased area of street room thereby available, and the right of "ancient light," which should never be ignored, would receive more consideration. The fire hazard, due to adjoining buildings, would be greatly lessened, and by the use of lines of distributing water pipes at the several story lines, known as the "Water Curtain," and fire shutters, with fusible plugs at points of greatest exposure, the danger of destruction by fire would be almost entirely obviated.

Such a radical departure from present block plans would require a readjustment of property lines and street lines, but it would soon justify itself by the advantages it brought with it. It seems hardly like intelligent action to make dark cañons of the streets, nor would it impress a student of the requirements as at all necessary.

If some legislative regulation required a minimum amount of sunlight on the streets, somewhat on the lines suggested by Mr. Sloan, coupled with the requirement that each building should stand detached, there would be not only a great gain for sanitation, cheerfulness and beauty of the street itself, but a great gain in the architectural treatment of the buildings, and a much-needed improvement in the sky line of the streets. Then, buildings designed under dissimilar ideas and requirements would not adjoin, and the sense of harmony, now so sadly lacking when two or more great buildings stand shoulder to shoulder, could not be ruthlessly disregarded.

Mr. Furber. The rearrangement of streets in Paris offers a precedent for intelligent action.

Æsthetic considerations alone should place no limit on the height of buildings, but the practical limitations of sunlight and air should keep this height within bounds of conservatism. The architectural design should be influenced by structural necessities, and correct æsthetic design should recognize the skeleton in the building and not attempt to conceal it. The root of the trouble is in attempting to treat architecturally a material of high resistance, like iron, with the same proportion—or slight modification of it—as stone. The fundamental basis of all architectural forms was originally the resistance of the material used to change of form from external forces, and the necessary dimensions for these forms guided the mind in shaping them. The age of stone architecture is past, and it is folly to treat the high building in a style adapted to stone only. The iron structure demands a freer hand, and an acknowledgment that the material used possesses both tensile and compressive strength; and with this recognition of the material should come an acknowledgment, also, of its weaknesses in high temperatures, by providing sufficient covering for efficient fireproofing.

When the change was made from building with masonry piers to building with iron columns, the reduction in the area of the piers was so great and so easy, and the window space, or open space, seemed so desirable, that the size of the pier was frequently diminished to little more than the area of the metal column, with a minimum of covering. This has made iron buildings in many cases unsafe and dangerous to their surroundings, and has placed too great a responsibility upon an insignificant amount of fire proofing, and this defect alone has called for a limit to the height of structures which are so deficient in this respect.

Another defect in a great deal of high building construction, is the carelessness, or ignorance, of the designers in failing to take precautions to prevent corrosion, and when the first building begins to fail from the corrosion of the main lines of its support, there will be most likely a shrinkage in the estimated value of many other buildings built on similar lines, and the good buildings will suffer with the bad, because few will be able to tell one from the other.

There is little doubt that ironwork can be made practically rust proof, as well as fire resisting—within practical limits—if the proper thought and study are given to the problem, but because it is out of sight it is out of the mind of many who are intrusted with great responsibilities in this respect.

So, therefore, it seems as if the limitations of high buildings are practical ones, which should be squarely met, and the various factors making up these limitations must either be given adequate consideration, or a surrender made when terms cannot be honorably obtained.